INFORMATION REQUEST FLAG

THIS FORM IS USED TO SAFEGUARD FROM INADVERTENT DESTRUCTION RECORDS THAT ARE INVOLVED IN FREEDOM OF INFORMATION ACT OR PRIVACY ACT REQUESTS, LITIGATION, OR MATTERS UNDER INVESTIGATION BY THE DEPARTMENT OF JUSTICE OR CONGRESS. IT MUST BE FILED IN THE FRONT OF A FOLDER TO LIST ALL DOCUMENTS IN THE FOLDER RELATED TO A SPECIFIC REQUEST *(one form for each request)*, OR AS A SINGLE ATTACHMENT TO EACH INDIVIDUAL DOCUMENT. IT MUST NOT BE REMOVED FROM THE DOCUMENT OR FOLDER UNTIL THE RECORD SERIES IS DUE FOR DESTRUCTION IN ACCORDANCE WITH APPROVED RECORDS CONTROL SCHEDULES AT WHICH TIME DISPOSITION OF FLAGGED RECORDS WILL BE CHECKED WITH THE COMPONENT RECORDS MANAGEMENT OFFICER AND OTHER AUTHORITIES AND WILL BE DEPENDENT ON THE STATUS OF EACH REQUEST.

TYPE OF REQUEST

	PRIVACY ACT		CONGRESSIONAL INVESTIGATIONS		OTHER *(specify)*
✓	FOIA		DEPT. OF JUSTICE INVESTIGATIONS		
	LITIGATION		MANDATORY CLASSIFICATION REVIEW		

REQUESTER	REQUEST NO.
SUBJECT OF REQUEST Behavioral Research	DATE OF REQUEST

DOCUMENTS SUBJECT TO REQUEST - INCLUDE FILE NO., SYMBOL, DATE AND SUBJECT

☐ CONTINUED ON SEPARATE PAGE

REMARKS

☐ CONTINUED ON SEPARATE PAGE

DATE OF COMPONENT RESPONSE	DATE APPEALED *(if applicable)*

DO NOT REMOVE THIS FORM FROM THIS FILE

FORM 9-77 4016

INFORMATION REQUEST

7 DEC 1965

PHOTOINTERPRETATION

1. Aerial photography has become increasingly important to the Agency both as a means of receiving initial information of military and economic importance and of confirming information from other sources. Recognition of this has stimulated the design of better collection systems for receiving higher resolution photographs for processing. Simultaneously, the entire process from initial collection through interpretation at NPIC has gone through repeated reviews. It has become apparent that increasing the number of high resolution photographs and the amount of information in each is not an unmixed blessing. It has resulted in increased demands and consequent stresses on the NPIC System.

2. Briefly, the system works as follows: The film is processed and ancillary and historical data on specific targets in the photographs, or on geographic coordinates are collated. These procedures are being increasingly optimized from a production standpoint and more and more automated with more or less concern with the primary user group - the photointerpretation staffs.

3. Then the individual interpreter, whose perception is in part predetermined by his prior experience and by the requirements levied on him, abstracts some of the requirements levied on him, abstracts some of the information in the photograph and communicates it primarily in the form of reports to the analyst.

4. It is the thesis of this report that examination of the data processing system at NPIC is best conducted in terms of the photointerpreter. His is a key role. He is the primary mediator between the potential information available in the photograph and the actual data transmitted. It is our suggestion that we examine the interaction of interpreter and photograph in the manner presented below. The data so gained is needed to increase the interpreter's efficiency. It is also needed to better coordinate the activities of the other components of the system, both those which present the interpreter with the raw information, and those analysts who need this data for further evaluation.

5. Long Range Objectives:

If it is accepted that the NPIC information system may be meaningfully analyzed in terms of the interpreter, then different catagories of information not presently available are required. The process whereby the interpreter both detects the pertinent information in the photograph, interweaves informational items outside the immediate photographs, and labels areas of the photograph ("SAM site" or "SUB", etc.) must be quantitatively determined. Moreover, the process should be studied in terms of the following factors:

(1) The interpreter's instructions set i.e., the intelligence requirements list and his interpretation thereof.

(2) The constraints imposed by psychophysical and physiological factors.

(3) The "image-quality" features of the actual photograph.
(4) The types of information added to material actually "seen" in the photograph..
(5) The number of individual photographs handled per unit time and the "contextual" complexity of each.

6. <u>The Photointerpretator's Task</u>:

On its most elementary level a photograph may be considered as a matrix of irregular dots, elements, which vary in size, shade of gray, and clustering or organization. As the interpreter primed by his instructions to find representations of particular groups of objects looks upon this matrix, he does essentially two things; first, he scans the photograph and "targets in" on a particular subset of the matrix which is sufficiently distinct in organization, or tonal patterning to be detectable against all the other neighboring points which now constitute its background. Secondly, he concentrates on this chosen subset by enlarging it, by relating it to neighboring subsets, and by relating it to other comparable subsets in previous photographs.

7. At some point, a label, a name, is assigned to the subset. It this label is one within the instruction set the interpreter may proceed further in "interpretion" - examining smaller groupings of elements within the "object". The meaningfulness, the labeling, of some of the smaller groupings and the rejection of others is governed, in part, by the label assigned to the larger subset. Or the second process may be reversed in that small clusters of elements act as cues for the interpreter to look selectively at neighboring small groups. Varying degrees of importance are assigned to the presence or absence of certain clusters or patterns or tonal variations. They are intergrated into a concept and labeled.

8. The targeting in and the final interpretation are not independent processes, nor do they necessarily take place in sequence. We can, though, for purposes of analysis isolate the two. Of the two, examination of the first process, the initial scan and localization of the area of interest, should be the first to be investigated. It is more dependent on basic visual processes which can be studied psycho-physically. It permits us to evaluate at the same time the factors of instruction set and image quality. In addition, it is necessary as background information for a serious investigation of how the interpreter relates units into a concept.

9. Experimental objectives:

To understand how the interpreter scans and articulates the photo into figure and background, the primary question to be asked experimentally is: What factor or combination of factors determine that one or another subset of a photograph is detected and emphasized. The fundamental factors, our independent variables, are: size, edge, contrast, tonal patterning within a cluster (i.e., texture) connectivity of elements in space or in tone, (i.e., shape), average intensity of the subset, average intensity of the "background", tonal patterning of the background, and the nature and informational content of competing clusters as well as the separation between "objects".

10. Our conditioning variables are: the explicitness or non-directiveness of the search instructions, the subject's familiarity with the task, the time allowed for searching, and, most important, the type of photograph. That is to say, a photograph of a sub in a basin, descriptively a gray smudge on a slightly different shade of gray, differs radically from a photograph of an industrial constellation with its overabundance of shadings, borders, and distinctive features. There is no a priori reason to expect that those fundamental visual parameters most important in detection in one type of photograph will be of equal importance or of any importance in photographs of a different type.

11. Our dependant variables will be, depending on the particular experiment, the subject's response time, or his accuracy. The importance of the independent variables listed above has in varying degrees already been documented. But they have been analyzed in simple patterns such as homogenous light spots under conditions where the experimenter has complete control of the independent variables.

12. But we cannot rig a stimulus so that only one or two of the parameters of interest are present. We must begin with real photographs and deduce what the relevant factors are. We must be able to elicit a subject's response to the initial photograph, change rapidly one or more factors, record the new response, distort a portion of the photograph or blot out areas or relocate a subset spatially, and repeat the process until we are experimentally certain that, for the given type of photograph, we have uncovered those factors which optimize detection; or, coversely, those factors which maximally degrade the image so that no detection is possible.

13. For this purpose, using ordinary photographic means, we could create ahead of time a large file of a photograph and all variations of it that we may need. Aside from the amount of work involved in compiling each file, this method would not work. First of all, even restricting our instructions so that only a few objects were to be detected, the numbers of photographs involved would soon constitute a retrieval problem, since all possible variations would need to be available though, depending on the subject's response, only a part of the file would be utilized.

14. For example, using a limited number of objects of interest, a homogeneous background, and changing only one parameter at a time with respect to the master photograph we would need as a minimum: Number of photographs/file=(number of objects) x (number of size changes) x (number of intensity changes) x (number of distance between object + neighbors) x (number of edge accentuations) x (number of texture changes) + 1 (master photograph). If we use three objects of interest, five gradations in size, ten levels of intensity, five combinations of distances between objects, four edge accentuations and five texture types, we would need 15000 photographic variations of the orignial. Using a patterned background, introducing noise, or the ability to distort or degrade only a portion of one object, or to change two factors in one photograph, or to rotate an object or to remove an object from its normal position and relocate it in another part of the photograph, would rapidly increase the number of photographs in the file.

15. When we had completed a file which tests the effects of discrete, relatively large changes in our key factors we would still need a way to produce continuous, small changes in those variables which the subject's responses define as crucial.

16. To produce adequate stimuli and record the subject's response is to fulfill some of our requirements. In addition, we need to accurately measure the amount of each factor in the master photograph and in its variations if we are to generate and test hypotheses relating critical factors to photograph type and instruction set.

17. <u>Equipment Requirements</u>:

We are saying, in brief, that in order to enhance the physical qualities of a photograph usefully we need hard data on which ones the interpreter responds to under varying conditions. To obtain this data efficiently we need certain specialized equipment. These hardware specifications are implicit in the proposed experimentation detailed above. Let us rephrase our requirements in terms of the type of equipment which will give us the capability of truly interfacing man and machine.

1. The visual display presented to the interpreter must satisfactorily simulate "real" photographs, or real photograph degraded by noise. At other times, we would need artificial photographs generated by patterns of discrete dots which conform to particular mathematical models.

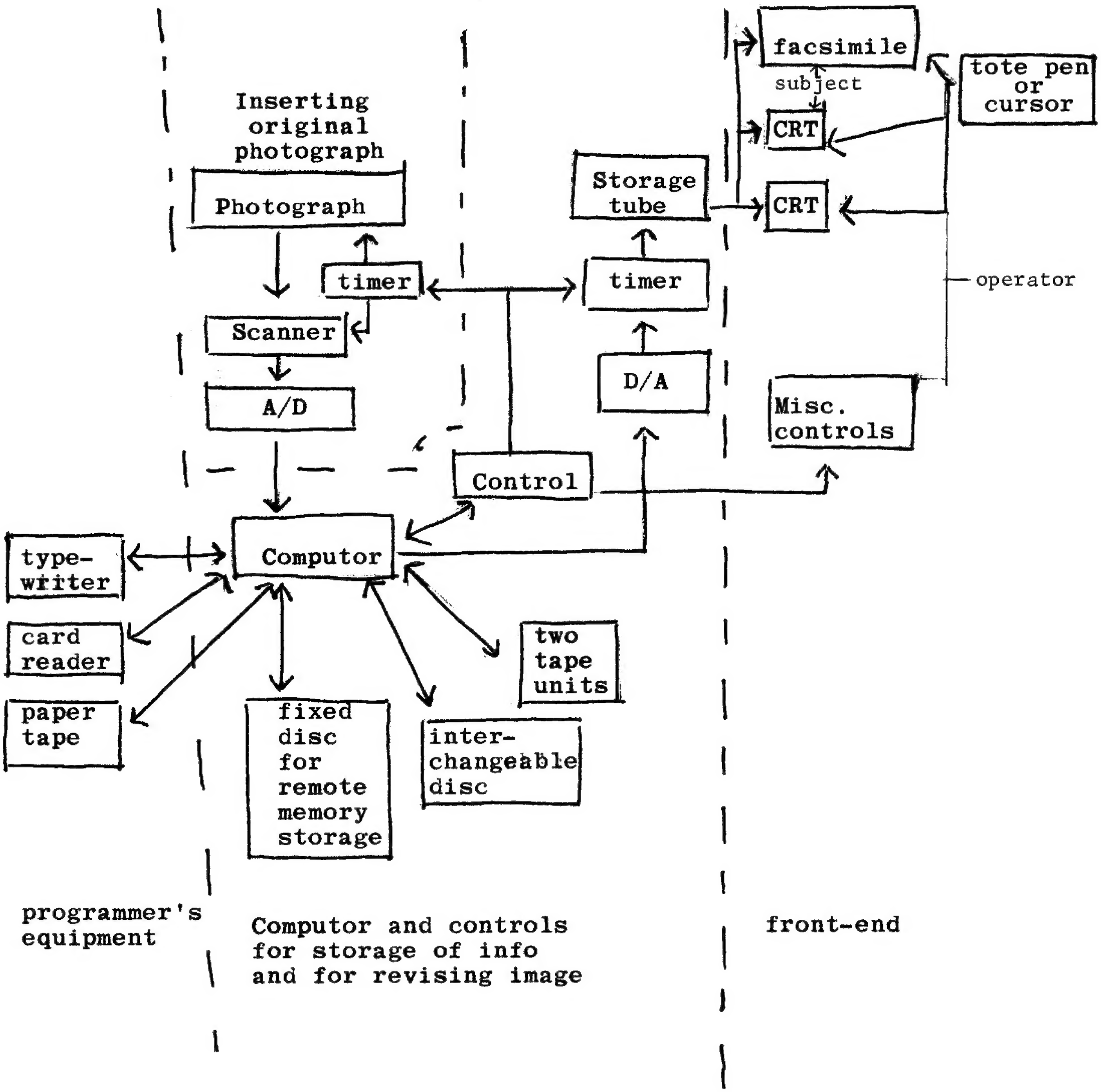
2. The stimulus of the photograph and the response of the subject can not be static or oneway. On the contrary, the man's response must initiate changes in some qualities of the image which in turn will change the man's response. Flexibility, ease, and rapidity in changing parts of the pattern are prime considerations.

3. A permanent record of the status of each element in the photograph and of the subsets articulated by the interpreter for each change in the photograph must be available during on-going data collection or post hoc data analysis.

18. Present computer design capability would argue for the desirability of an analogue-type visual presentation to the photointerpretor-subject. In addition, the subject must be able to indicate directly to the machine his area of attention by simply pointing with a lite-pen, curser, etc. The experimenter must be able to direct real-time changes in the display, especially in those areas of indicated primary attention. Because of the precision required in such partial picture substitution and syntheses, it would appear desirable that digital processing of such areas take place. Representation of such digitally-processed areas on the visual display would require intermittent digital to analogue conversion with subsequent replacement. In order to approach the ideal of on-line processing, it would seem expedient that the system store a fully digitized version of the analogue presentation, which of course could be prepared off-line in advance of the individual experiment.

19. The foregoing criteria are for a hybrid (analogue plus digital) system for display and manipulation of images; a system which is not at present existant but one which does not demand capabilities too far beyond the present state of the art. A preliminary plan of such a system would be as follows: (See diagram)

DISPLAY SYSTEM



Insertion of Original Photograph:

We are assuming a 8" x 10" photograph or transparency and a scanner with a spot size $\frac{1}{200}$" in lateral resolution or 2.5 x 10^{-5} inches in area. The photograph then has 8 x 10/2.5 x 10^{-5} or 32 x 10^5 such elements. If we assume that 32 levels or 2^5 levels of gray will be required, than an additional 4 bits of information must be stored for each element, making a total number of bits of 4 x 2^5 (=32) x 10^5=2^7 x 10^5 = 128 x 10^5 bits to be stored in the remote memory disc and tagged so that portions of the image are readily retrivable.

Front-end:

The displays to the subject includes a facsimile system in addition to the usual TV CRT display. Where the TV display is usually capable of 1000 lines resolution and about 7-10 levels of gray, a fascimile system can resolive 2000 lines/1" and reproduce 64 shades of gray. The CRT display with less potential information is relatively easier for program and would be preferable in the production model. However, until we can spacify which qualitative analysis are valid with the resolution-and gray scale-limited CRT, both displays are required. The CRT for the operator is needed primarily for object location. The miscellaneous controls are to be used to call forth programs from the digital computor for changing portions of the display and for gross variations of contrast or texture by analog means.

It should be pointed out here that one unknown in the system is which changes can be controlled from analogue devices included in the miscellaneous controls without reducing the efficiency of the entire system.

Computor and Controls:

The computor must be capable of storing information about the entire image (the remote memory storage), of storaging programs for manipulating changes in size, texture, etc. in parts of the image (interchangeable disc and tapes), and of controlling the revised image or the display via the storage tube and associated electronic controls.

Of the 128 x 10^5 bits storing the original image, let us assume we will be namipulating a 1" x 1" portion of the picture at any one time. The computer then may, at any time be processing $\frac{1}{80"} = \frac{X}{128}$ x 10^5 or 160,000 bits of information at a time. By itself, it is reasonable to expect that this amount of information can indeed be processed in real time (i.e. within 30 sec to 1 min.) However, within that time, the computor must retrieve the information about that particular section of the photograph, run it through one or more programs, (eg, change size of object A, make all densities below D1 equal to D1, and transfer object A to position (X1 + H) (Y1 + L) on the screen) and revise the screen image.

Since factors in estimating time requirements include the programming subroutines needed and the physical characteristics of the images to be manipulated, whether manipulation of more than one change at a time is possible in real time has not yet been answered.

We have assumed as our minimum computor requirements a CDC 1700, a PDP 7, or possibly a SDC 930. That is a 32,000 word (16 bit/word) machine.

Between the computor and the display a storage tube and related electronics has been inserted. This is because the output rate of present-day computors or of computors in the forseable future is well under a megacycle, while TV imput requires a 4 megacycle rate.

<u>Programmers Section</u>:

The card, reader, etc, are not strictly part of the operating system, bur are for use of the programmer in writing and debugging the computor programs for inducing the changes in the image.

<u>Implementing the System</u>:

Preliminary talks with representations of the [redacted] 25X1
25X1 [redacted] indicate that the proposed system can be built from presently available components in 9 months to 1 year. The estimated cost, exclusive
25X1 of programming would be about [redacted] for the computor and [redacted] 25X1
for the other components. If the system is to succeed, three programs would need to be begun simultaneously; 1) The building of the display system, 2) The development of the software package, 3) The strategy of parameter manipulation in an unconventional experimental design.

The personnel requirement would be; 1) An electronic engineer, conversant with TV display systems and computors, to write the explicit specifications for the system, as well as to maintain it in use, 2) A full-time programmer with experience in machine programming for pictorial displays, 3) An experimental psychologist to formulate the experimental strategy and runs the actual expermentation.

It is suggested that we develop the display system by outside contract, while the programming and actual experimentation be done in-house.

DISPLAY SYSTEM

Object: To evaluate the factors in an aereal photograph (variations in contrast, texture, size, border, location of an object relative to its background and number of competing objects) taking the parameters, 1 to n at a time, which increase the probability that a photointerpreter will detect an object, or conversely maximally minimize the probability of detection.

Method: Given a particular type of aereal photograph and a particular set of instructions, to record the subject's response time and object chosen, and on the basis of his response, iteratively manipulate parameters of the image, until the combination of parameters yielding optimum detection have been determined.

Equipment Needed: A CRT and facsmile display of the image under control of a digital computor whereby the operator can implement local changes in border, size, etc., in the display in real time in response to the subject's response.